TEMPERATURE TOLERANCE OF TWO AMPHIPOD SPECIES UNDER KIEL FJORD CONDITIONS: BALTIC *VS*. CASPIAN SEA SPECIES

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Abstract
In this study, we tested temperature tolerance of two amphipod species, one originating from the Baltic Sea (*Gammarus oceanicus*) and another from the Ponto-Caspian region (*Pontogammarus maeoticus*) to determine their performance under current and future global warming scenarios. Both amphipod species perform rather similar in temperatures from 6 to 22°C. However, above 24°C, only *P. maeoticus* survived, indicating that in the case of global warming *P. maeoticus* that evolved under higher temperatures of the Caspian Sea might outcompete *G. oceanicus*, which evolved under lower temperatures of the Baltic Sea.

Keywords: NIS, Temperature, Baltic Sea, Caspian Sea

New non-indigenous species are constantly arriving to the Baltic Sea, most likely via ballast water, hull fouling and/or aquaculture [1,2]. A relatively high number of those species originate from the Ponto-Caspian region (*i.e.*, Black, Azov and Caspian Seas) [3], with some of them, such as the amphipod *Echinogammarus ischnus*, known to have high impact on local communities and ecosystem functioning [1]. In addition, future global warming may open new environmental and niche opportunities for continuously arriving species [4]. Here, we tested temperature tolerance of two amphipod species, one originating from the Baltic Sea (*Gammarus oceanicus*) and another from the Ponto-Caspian region (*Pontogammarus maeoticus*) to determine their performance under current and future temperature conditions. *P. maeoticus* has been chosen due to its invasion history in freshwater areas of Turkey, but not in the Baltic Sea [1,2,5].

Specimens of *P. maeoticus* and *G. oceanicus* were collected in October 2014 in South Caspian Sea (Iran) and in May 2015 in Kiel Fjord (Germany), respectively. The species were kept at their natural salinity and temperature until the common garden experiment started (*i.e.*, 18°C, 10 ppt and 16°C, 16 ppt, respectively). The experiment was performed in Kiel in November and December 2015, and consisted of a control, a warm (increasing temperature) and a cold (decreasing temperature) treatment. Each treatment was replicated three times with ten individuals of each species per replicate. Two 1-l beakers with mesh on the sides, each containing one species, were submerged in a tank allowing water exchange, but preventing direct contact between species (*i.e.*, one replicate). The salinity during the whole experiment was 16 (±0.2) ppt, light/dark cycle was 12:12 hours, and the starting temperature was 16°C. During the experiment, temperature was decreased/increased by 2°C every three days until reaching 6 or 28°C. Animals were fed ad libitum with a mixture of algae flakes. Water was exchanged every three days by replacing half of the volume. Temperature and salinity were monitored every day, while survival was checked every three days during the water exchange.

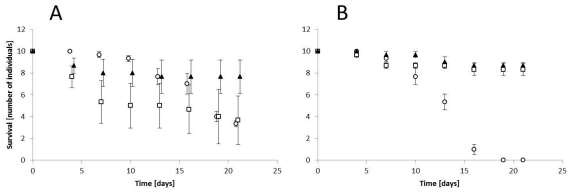

Fig. 1. Survival rates (abundance: mean ± SE, N=3 each) for *Pontogammarus maeoticus* (**A**) and *Gammarus oceanicus* (**B**) at three different temperature treatments (control (white square), warm (white circle) and cold (black triangle)). In (**A**) data points of the same day were slightly shifted to better distinguish the error bars of the different treatments.

At the end of the experiment, survival of *P. maeoticus* was between 0 and 90%, 30 and 40%, and 40 and 100% in the control, warm, and cold treatment, respectively (Fig. 1A). In the warm treatment, survival was rather high until 22° C (90 to 100%; Fig. 1A). In the case of *G. oceanicus*, survival was between 70 and 90%, 0%, and 80 and 100% in the control, warm, and cold treatment, respectively (Fig. 1B). In the warm treatment, all *G. oceanicus* died at 26°C (Fig. 1B).

The present study revealed that both amphipod species perform rather similar in temperatures from 6 to 22°C. Survival rates of *P. maeoticus* varied in the control treatment, which might be due to the salinity change that the species experienced during the experiments. Nevertheless, *P. maeoticus* survived relatively well in the warm treatment, while all *G. oceanicus* died up to 26°C. Our study predicts that in the case of global warming *G. oceanicus*, which evolved under lower temperatures of the Baltic Sea, would not be able to compete with *P. maeoticus* that evolved under higher temperatures of the Caspian Sea. Salinity stress and chemical composition of the Baltic Sea water had less effect on *P. maeoticus* than temperature stress on *G. oceanicus* which indicates that *P. maeoticus* have potential to become a non-indigenous species in Kiel Fjord and probably the Baltic Sea.

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